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INTRODUCTION

Motivation

The precise analysis of GNSS observation data is based upon a variety of station and satellite metadata. The characteristics of the applied receiver and antenna hardware, local characteristics (e.g. coordinates and ocean loading) as well as satellite features and their behavior must be established. A high evaluation quality must be ensured by the consistency, integrity and validity of these metadata.

The station and satellite metadata are currently maintained in ASCII files in different formats. This kind of storage and the missing validation routines lead to a higher effort in the maintenance and a higher risk of inconsistencies of these files. Following this approach the extraction of key information used for innumerable queries is unmanageable. Another issue concerns the variety of sources to collect all necessary metadata (e.g. satellite maneuver messages, satellite parameters, ocean loading coefficients) for the Analysis Centers (AC), so that it cannot be ensured that all AC's use the same set of metadata.

Objective

The objective of this project is the development of a system for the management of all station and satellite metadata (**SEMISYS** – Sensor Meta Information System) needed for the analysis of GNSS observation data. All necessary information are stored format independent and validated in a central relational database to get rid of the restrictions caused by the file based metadata management.

The overall purpose is to manage all metadata in one hand. The access is realised by a FTP/HTTP interface. This approach ensures, that all AC's use the same set of metadata, so that the risk of corrupt metadata can be minimized. Besides it could be used to develop a unified exchange format for all different types of metadata.

SEMISYS IN A NUTSHELL

System design

SEMISYS is designed to meet the expenses of different user groups: users who use the system as a pure information system accessible by a web browser (interactive web mode) and users who want to create files for their daily routine automatically (batch mode).

The backbone of this system is the central database that contains all necessary metadata for the analysis of GNSS observation data as well as information used for the general system (e.g. for the protection of data). The central storage ensures the consistency, integrity and instant access to these information.

Batch mode

The batch mode has been implemented for the daily monitoring of metadata files that undergo frequent changes (e.g. IGS site logs) and should be processed automatically to keep the database contemporary independent from an operator.

Another task addresses the automatic generation of files used for the analysis routine. Due to the object-oriented approach it can be adopted to generate files in different formats.

Database and metadata content

The developed system includes the following metadata:

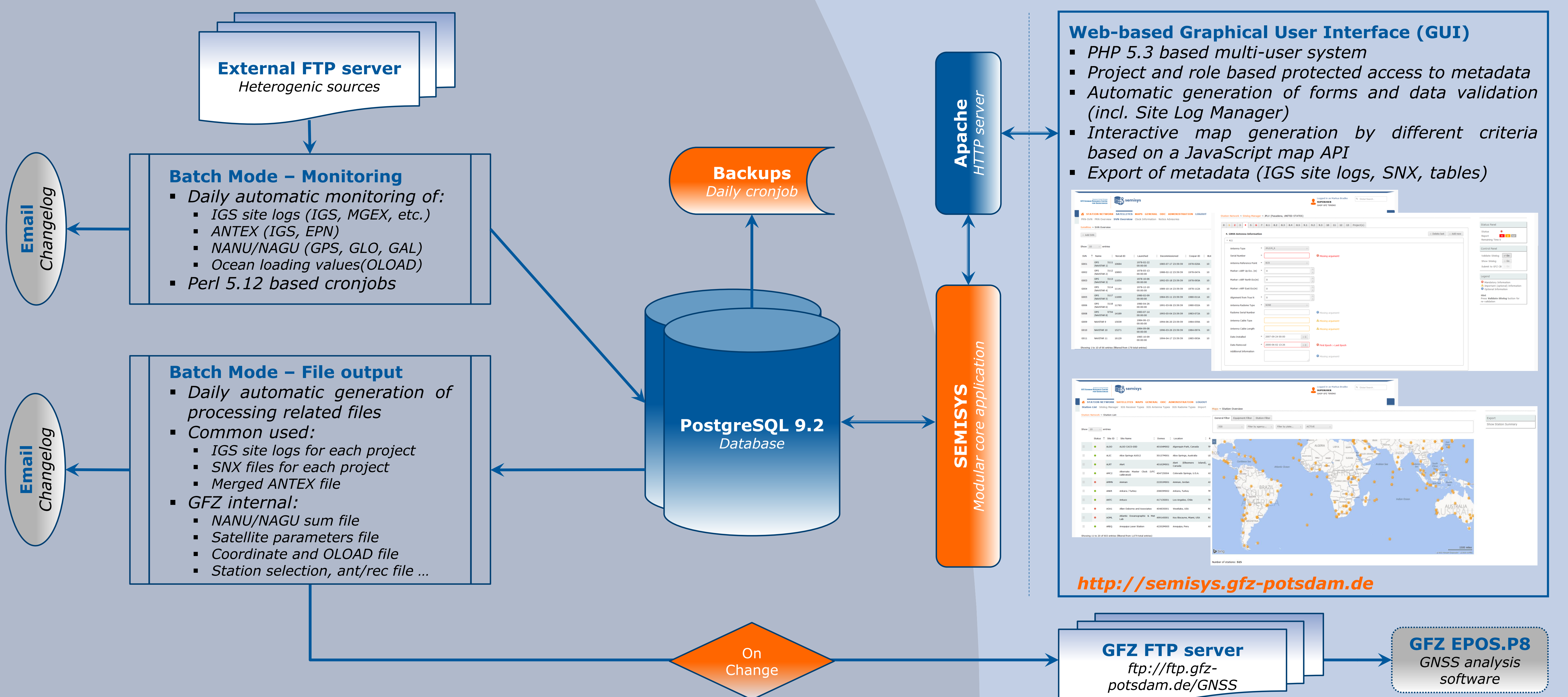
- **Station metadata**
 - All information extracted from *IGS site logs*
 - Initial coordinate solutions calculated by *GFZ EPOS.P8*
 - Ocean loading values calculated by *Onsala Space Observatory*
- **Hardware metadata**
 - Receiver/antenna/radome types extracted from the *IGS rcvr_ant.tab*
 - Receiver dependent observation types extracted from receiver format descriptions
 - Antenna graphics extracted from the *IGS antenna.gra*
- **Satellite parameters** for the GNSS systems GPS, GLONASS, Galileo, BeiDou, QZSS and SBAS
 - Core information extracted from format descriptions of the satellite manufacturers
 - Validated and stocked up by information from *ANTEX*
- **Satellite maneuver** information, extracted from:
 - GPS NANU: *US Coast Guard Navigation Center*
 - GLO NAGU: *GLONASS Information-Analytical Centre*
 - GAL NAGU: *European GNSS Service Centre*

Interactive mode / Implemented features

The interactive web mode is designed to provide short-term access to information about stations and satellites. At the moment it is used primarily as a viewer because most metadata are collected automatically via batch mode. It is also equipped with a unique interface to update satellite and general metadata via web-based forms. In addition a Site Log Manager (SLM) was implemented to update station metadata. The SLM is a web-based editor stocked with a strict on-the-fly syntax and plausibility validation tool, that only allows the import of validated information.

Another highlight is the interactive station map based on a JavaScript map API (Application Programming Interface). The stations are displayed by the coordinates deposited in the IGS site logs and can be filtered by different criteria (e.g. project, agency, plate, hardware). The filter can be easily extended by other criteria.

Due to the multi-user approach SEMISYS contains classes for the user/system authentication and data protection by different roles and rights. Other classes consider the locking of data records for editing, logging mechanisms by changes on the data pool and errors in the application.



Basic system design of SEMISYS, data flow and client/server communication.

The screenshots on the right (GUI) show from top to down: satellite overview, Site Log Manager (SLM), station overview and interactive station map

SEMISYS@IGS

SEMISYS has been implemented at GFZ Operational Data Center (ODC) and continuously improved since 2012. It contains all relevant metadata used for the analysis of GNSS observation data and runs in a stable environment. The database based approach has several advantages with respect to the file based data handling, e.g.:

- Central, easy and fast on-demand access to metadata,
- Easy build-up of connections between metadata by means of SQL (Structured Query Language),
- Easy maintenance of station and satellite metadata based on a web editor,
- Validation of all incoming metadata,
- Easy and flexible generation of input files for different analysis software packages (e.g. EPOS.P8, Bernese, PANDA, etc.) due to the format independent storage.

GFZ, as IGS AC and contributor to most IGS activities (e.g. MGEX, IGS-RT), is predestined to manage all station and satellite metadata. The "all-in-one-hand" solution would be a benefit for the whole community and the market place for any GNSS metadata. The GFZ ODC provides a project overlapping ready-to-go system with consistent, valid and accurate metadata.

CURRENT DEVELOPMENTS AND OUTLOOK

SEMISYS is the base for all future implementations regarding the improvement of the GFZ ODC routine software. The up-to-date metadata in the database could be used to create (historic) RINEX-Header for binary observation files recorded by GFZ's GNSS stations. In addition a validation of the metadata (installed receiver/antenna, possible observation types for receiver, satellite PRN including valid time intervals) in the RINEX-Header to the metadata in the database could be realised, so that no corrupt observation files are processed.

Another project addresses the development of an observation database (GFZ ObsBase) that contains validated RINEX observation data of all incoming files. This approach leads to a variety of advantages affecting the extraction of required data on-demand by a criteria based selection (e.g. satellite systems, observation types, time intervals, etc.). The first studies and results in this field have been promising.

A by-product of the GFZ ObsBase is a monitor that provides a full set of statistical information (available observation types, satellite systems, latency, etc.) about RINEX observation files.